Use of COMSOL As a Tool in the Design of an Inclined Multiple Borehole Heat Exchanger

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Abstract

A field of connected boreholes can be used both for cooling, heating and storage purposes and the boreholes can either be straight or inclined to save surface area usage. The boreholes transfer heat to or from the ground, which over time changes the temperature in the ground. This in turn changes the performance of the borehole field and the ground source system. An undersized borehole field will be exhausted before the projected lifetime and a too large field will give higher costs. Because of this it is important that the borehole field is properly sized and evaluated before the construction.

This study presents results from borehole field evaluations of inclined boreholes used for cooling purposes, modeled with the software COMSOL Multiphysics. Both a uniform ground temperature and a ground temperature gradient are considered. Values from measurements and literature are used as boundary conditions.

The three dimensional problem is solved with transient heat transfer equations and the borehole surface temperature is obtained after several years of operation. Using the borehole resistance, the fluid mean temperature in the boreholes is calculated. Temperature distribution and flow directions illustrate the results.

A correct borehole length and configuration that meets the temperature requirements can be determined.